

AMENDMENTS TO THE CLAIMS

Claims 1-60 (Cancelled)

61. (Currently Amended) A modular apparatus for painting surfaces of a vehicle body moved along a path comprising:

a modular apparatus including two guide rails; and
at least one robot located on and movable along the length of each of said two
guide rails;

said guide rails comprising a pair of frame rails located on opposite sides of and extending generally parallel to the path of movement of the vehicle body, said frame rails being located above a plane of an upper surface of the vehicle body as the vehicle body travels the path, said frame rails being fixedly mounted on a rigid frame structure that prevents movement of one of said frame rails relative to another of said frame rails;

said at least one robot comprising a first and a second robot arm mounted on an associated one of each of said frame rails, each of said first and second robot arms being slidably movable along said associated frame rail and having a shoulder axis and an elbow axis for movement only in a generally vertical plane transverse to the path of movement of the vehicle body, said shoulder axes being positioned below said associated frame rail; and

a paint applicator mounted on each of said first and second robot arms for dispensing paint whereby each of said first and second robot arms is sized to move said paint applicator relative to the vehicle body while said paint applicators dispense paint to cover the upper surface and adjacent side surfaces of the vehicle body with the paint.

62. (Previously Presented) The apparatus according to Claim 61 wherein each of said first and second robot arms includes a wrist mounting said paint applicator, said wrist having a rotating axis and a tilting axis for moving said paint applicator relative to the vehicle body.

63. (Previously Presented) The apparatus according to Claim 61 wherein each of said first and second robot arms moves in a generally vertical plane transverse to the path of movement of the vehicle body to dispense the paint.

64. (Previously Presented) The apparatus according to Claim 61 wherein said frame rails are mounted on walls of a paint booth extending generally parallel to the path of movement of the vehicle body.

65. (Previously Presented) The apparatus according to Claim 61 wherein said frame rails are mounted on floor engaging legs.

66. (Previously Presented) The apparatus according to Claim 61 wherein said frame rails are tubular.

67. (Previously Presented) The apparatus according to Claim 61 wherein said frame rails are connected by at least one cross support member located above the plane of the upper surface of the vehicle body.

68. (Previously Presented) The apparatus according to Claim 67 wherein said frame rails and said at least one cross support member are tubular.

69. (Previously Presented) The apparatus according to Claim 61 including control means maintaining said first and second robot arms in opposition to provide symmetric painting of the vehicle body.

70. (Previously Presented) The apparatus according to Claim 61 wherein each said shoulder axis extends parallel to and is offset horizontally from an axis of travel along said associated frame rail.

71. (Previously Presented) The apparatus according to Claim 61 wherein each said shoulder axis extends parallel to and is offset horizontally from an axis of travel along said associated frame rail toward the path of movement of the vehicle body.

72. (Currently amended) A modular apparatus for painting a vehicle body having an upper surface and opposed side surfaces and being conveyed along a path comprising:

a modular apparatus including two guide rails; and

at least one robot located on and movable along the length of each of said two guide rails;

said guide rails comprising a pair of frame rails extending along opposite sides of and generally parallel to the path of conveyance of the vehicle body;

at least two legs attached to each said frame rail for supporting said frame rails above a plane of the upper surface of the vehicle body on the path;

at least one cross member fixedly connecting said frame rails together as a rigid frame structure that prevents movement of said frame rails, fixes said frame rails relative to one another and to said plane, and minimizes a width of said rigid frame structure relative to a width of the vehicle body;

said at least one robot comprising at least one robot arm located on an associated one of each of said frame rails, said at least one robot arm being movable along said associated frame rail generally parallel to the path and being pivoted at a shoulder axis positioned below said associated frame rail; and a paint applicator mounted on each said at least one robot arm for applying paint to the vehicle body whereby each of said at least one robot arms pivots at said shoulder in a generally vertical plane to permit each of said at least one robot arms to reach said paint applicator to all paintable areas on the upper surface and an adjacent one of the side surfaces of the vehicle body.

73. (Previously Presented) The apparatus according to Claim 72 wherein each of said at least one robot arm has an inner arm portion pivoted at one end at said shoulder axis and pivotally connected at an opposite end to an outer arm portion at an elbow axis.

74. (Previously Presented) The apparatus according to Claim 72 wherein each said at least one robot arm includes a process controller mounted for movement therewith along said associated frame rail.

75. (Previously Presented) The apparatus according to Claim 74 wherein said at least one cross support member is hollow and receives cables and conduits connecting said process controllers together.

76. (Previously Presented) The apparatus according to Claim 74 wherein said at least one cross support member is tubular and purged with an inert gas or air for explosion protection.

77. (Previously Presented) The apparatus according to Claim 72 wherein each said at least one robot arm includes a wrist connecting a free end of said at least one robot arm and said paint applicator, said wrist having two axes of motion.

78. (Previously Presented) The apparatus according to Claim 72 wherein each said at least one robot arm has only four axes of motion including said shoulder axis for orienting said paint applicator relative to the vehicle body.

79. (Previously Presented) The apparatus according to Claim 72 wherein each said shoulder axis extends parallel to and is offset horizontally from an axis of travel along said associated frame rail.

80. (Previously Presented) The apparatus according to Claim 72 wherein each said shoulder axis extends parallel to and is offset horizontally from an axis of travel along said associated frame rail toward the path.

81. (Currently Amended) A modular apparatus for painting surfaces of a vehicle body moved along a path through a paint booth comprising:

a modular apparatus comprising at least one horizontally extending guide rail; and at least one robot arm including a controller mounted on said rail for travelling along said rail; wherein said guide rail comprises a pair of frame rails mounted on opposite sides of and extending generally parallel to the path of movement of the vehicle body through the paint booth, said frame rails being fixedly located above a plane of an upper surface of the vehicle body as the vehicle body travels the path; and

said at least one robot comprises a first and a second robot arm mounted on an associated one of each of said frame rails, each of said first and second robot arms being movable along said associated frame rail and having a shoulder axis and an elbow axis for movement only in a generally vertical plane transverse to the path of movement of the vehicle body, said shoulder axes being positioned below said associated frame rail; and

a paint applicator mounted on each of said first and second robot arms for dispensing paint whereby said first and second robot arms are sized to move said paint applicators relative to the vehicle body while said paint applicators dispense paint to cover the upper surface and an adjacent side surface of the vehicle body with the paint; and

wherein said control means is connected to each of said first and second robot arms for selectively dispensing the paint in a normal mode wherein different areas of the upper surface and the adjacent side surface are covered by said paint applicators of each of said first and second robot arms and a degraded mode wherein the upper surface and the adjacent side surface are covered by said paint applicator of one of said first and second robot arms.

82. (Previously Presented) The apparatus according to Claim 81 wherein said first robot arms are positioned in opposition and said second robot arms are positioned in opposition to provide symmetric painting of the vehicle body.

83. (Previously Presented) The apparatus according to Claim 81 wherein said control means includes a separate process controller mounted on an associated one of each of said first and second robot arms for movement along said associated frame rail, each said process controller operating said associated robot arm in the normal mode and the degraded mode.

84. (Previously Presented) The apparatus according to Claim 81 wherein each of said first and second robot arms includes a wrist mounting said paint applicator, said wrist having a rotating axis and a tilting axis for moving said paint applicator relative to the vehicle body.

85. (Previously Presented) The apparatus according to Claim 81 wherein said frame rails are mounted on walls of a paint booth extending generally parallel to the path of movement of the vehicle body.

86. (Previously Presented) The apparatus according to Claim 81 wherein said frame rails are mounted on floor engaging legs.

87. (Previously Presented) The apparatus according to Claim 86 wherein frame rails are connected by at least one cross support member located above the plane of the upper surface of the vehicle.

88. (Previously Presented) The apparatus according to Claim 87 wherein said frame rails and said at least one cross support member are tubular and receive cables and conduits connecting said first and second robot arms together.

89. (Previously Presented) The apparatus according to Claim 81 wherein each of said first and second robot arms has four axes of movement including said shoulder axis and an elbow axis defining a planar operating space for said paint applicator transverse to the path of movement of the vehicle body and including a wrist rotating axis and a wrist tilting axis for moving said paint applicator.

90. (Currently amended) A modular apparatus for painting surfaces of a vehicle body moved along a path comprising:

a modular system including two guide rails; and
at least one robot located on and movable along the length of each of said two guide rails;

said guide rails further comprising a pair of frame rails located on opposite sides of and extending generally parallel to the path of movement of the vehicle body, said frame rails being elevated above a plane of an upper surface of the vehicle body as the vehicle body travels the path, said frame rails being mounted on a fixed rigid frame structure that prevents movement of one of said frame rails relative to another of said frame rails, and prevents movement of said frame rails relative to said plane; and

a first and a second robot arm mounted on an associated one of each of said frame rails, each of said first and second robot arms having a carriage movable along an associated one of said frame rails, first and second arm links, and mounting means for mounting a paint applicator at an end of said second arm link, three parallel axes of movement including a first linear axis wherein said carriages move along said associated frame rails, a second rotational axis located below said first linear axis for rotating said first arm link relative to said carriage and a third rotational axis spatially separated from said second rotational axis by said first arm link for rotating said second arm link relative to said first arm link whereby movement of a paint applicator attached to said mounting means is restricted to a generally vertical plane transverse to the path of movement of the vehicle body and movement along the path of movement of the vehicle body; and

said robot arms further comprising a paint applicator mounted on each of said first and second robot arms for dispensing paint whereby each of said first and second robot arms is sized to move said paint applicator relative to the vehicle body while said paint applicators dispense paint to cover the upper surface and adjacent side surfaces of the vehicle body with the paint.

91. (Currently amended) A modular apparatus for processing an article moved along a path comprising:

a modular system including two guide rails; and
at least one robot located on and movable along the length of each of said two
guide rails; said robot including a control system; and

a said robot having six axes of motion and being connected to said control system
for controlling movement of said robot,

said robot modular system having a frame structure including first and second linear and parallel guide rails, a first carriage supported on said first guide rail and movable along a first of said six axes and a second carriage supported on said second guide rail and movable along a second of said six axes, a first arm link rotationally coupled at one end to said first carriage at a third of said six axes and rotationally coupled at another end to a second arm link at a fourth of said six axes, a third arm link rotationally coupled at one end to said second carriage at a fifth of said six axes and rotationally coupled at another end to a fourth arm link at a sixth of said six axes, and process tool mounting means supported at terminal ends of said second and fourth arm links, wherein said first and second guide rails are elevated above the article on opposite sides of the path and said six axes are parallel to the path.

92. (Previously presented) The apparatus according to Claim 91 wherein said third and fifth axes are located below said first and second guide rails and above a top surface of the article and wherein said first through fourth axes are fixed in space relative to one another as said robot performs process operations on the article.

93. (Previously presented) The apparatus according to Claim 91 wherein said mounting means is a robotic wrist mechanism having at least one rotational axis for providing directional orientation to a process tool mounted on said wrist mechanism.

94. (Previously presented) The apparatus according to Claim 91 including a paint applicator mounted on each of said mounting means and wherein the article is a vehicle body to be painted.

95. (Previously presented) The apparatus according to Claim 94 wherein the first and second arm links are sized to move said paint applicator relative to the vehicle body while said paint applicator dispenses paint to cover an upper surface and adjacent sides of the vehicle body with the paint.

96. (Previously presented) The apparatus according to Claim 91 wherein said frame structure has at least one hollow beam member.

97. (Previously presented) The apparatus according to Claim 91 wherein said control system is mounted in at least one of said carriages and is movable along an associated one of said first and second guide rails.

98. (Currently amended) A robot for processing an article moved along a path comprising:

a modular system including two guide rails; and
at least one robot located on and movable along the length of each of said two
guide rails; said robot including a control system conjoined with and
movable with said robot; and
wherein said guide rails form a robot base including a frame structure
having linear and parallel first and second guide rails;
a first carriage supported on said first guide rail and movable along a first
axis;
a second carriage supported on said second guide rail and movable along a
second axis;
a first link mechanism rotationally coupled to said first carriage at a third
axis;
a second link mechanism rotationally coupled to said second carriage at a
fourth axis; and
a process tool mounting means supported at terminal ends of said first and
second link mechanisms, wherein said guide rails are fixed and said modular
system is elevated above the article on opposite sides of the path.

99. (Previously presented) The robot according to Claim 98 wherein each of said guide rails supports at least another of said carriages and link mechanisms.

100. (Previously presented) The robot according to Claim 98 wherein said process tool mounting means includes a multiple axis wrist mechanism controlled by said control system.

101. (Previously presented) The robot according to Claim 98 wherein said first and second link mechanisms include fifth and sixth axes of rotation respectively and said first through sixth axes each extend in a substantially horizontal orientation